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Pre- and Post-fumigation Soil Assays of Fungal Populations Relative to Three Fumigation Treatments: Lucky Peak Forest Nursery

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INTRODUCTION

As a standard management practice the USDA Lucky Peak Forest Nursery in southwestern Idaho routinely fumigates fallow, tilled fields in late summer prior to spring sowing. The purpose is to reduce to manageable levels populations of soil-borne plant pathogens, insects, and weed seeds. For the past nine years Dowfume MC-33 (33% methyl bromide-67% chloropicrin) has been applied beneath a continuous-field plastic tarp at the rate of 350 pounds per acre. Fumigation costs per acre over the past three years have averaged $1076.00.

Previous pre- and post-fumigation soil assays at Lucky Peak Forest Nursery (Marshall 1983) and elsewhere (Fuller et al. 1980; Tkacz 1983) have shown fumigation with MC-33 to reduce populations of various plant pathogenic fungi to acceptable levels. However, in the fall of 1985 the nursery fumigated small areas of Field 14 with a less expensive fumigant, Telone C-17 (dichloropropene), to determine if acceptable efficacy could be attained at a lower cost. Effects of this fumigation upon weed seeds and insects will not be evaluated until next spring and summer. But soils were assayed during summer and fall, 1985, to compare pre- and post-fumigation levels of soil-borne plant pathogenic fungi. Assay results are reported here.

METHODS

Field history and fumigation. Recent cultural history in Field 14 includes spring sowing in 1983 with lodgepole, ponderosa, and Jeffrey pines. Seedlings were lifted in spring, 1985, and the field was left fallow. After cross-rip cultivation the field was fumigated in September, 1985.

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Three fumigation treatments were conducted. The treatments were: MC-33 with a continuous-field tarp, Telone C-17 with a continuous-field tarp, and Telone C-17 without a tarp. Each Telone C-17 treatment was applied to one-half acre while the MC-33 treatment encompassed the remainder (5+ acres) of the field.

Soil sampling. Five sample points were evenly spaced 50 ft apart along the longitudinal axis of each Telone C-17 treatment area and in an adjacent one-half acre of the MC-33 treatment area. In addition, 10 more sample points were similarly spaced in the remainder of the MC-33 treatment area to more thoroughly evaluate pre- and post-fumigation populations.

At each sample point soil samples were collected immediately prior to and one month following fumigation. For each 30 sq cm sample point, five soil cores were extracted by soil probe from the upper 15 cm of the soil profile. The five cores were combined in appropriately labeled bags and transported to the laboratory for evaluations.

Isolation methods. In the laboratory each five-core soil sample was thoroughly mixed and a small subsample placed into a sterile petri plate. After allowing subsamples to air-dry overnight at room temperature, 0.2 g of air-dried soil was extracted from each plate, added to 40 ml of 0.5% water agar, and thoroughly mixed. While in suspension 1 ml was drawn by sterile syringe and dispensed onto plates of Fusarium-selective PCNB (pentachloronitrobenzene) agar (Johnson and Curl 1972). This selective agar was used because Fusarium spp. have been frequently associated with seedling mortality at the nursery. Inoculated plates were stored at room temperature and examined within one week for presence of Fusarium spp. and other fungi. All Fusarium colonies growing on PCNB agar were then transferred onto plates of standard potato dextrose agar (PDA) for purposes of species identification. No attempt was made to identify other fungi to species.

RESULTS and DISCUSSION

The most frequently isolated fungi in pre-fumigation samples were Penicillium spp., Trichoderma spp., and Fusarium spp. Three species of Fusarium were identified using the identification manual of Nelson et al. (1983). Listed in order of descending frequency, they are: F. solani (Mart.) Appel & Wollenw. emend. Snyd. & Hans., F. oxysporum Schlecht. emend. Snyd. & Hans., and F. avenaceum (Fr.) Sacc.

Only Penicillium spp. and Trichoderma spp. were frequently isolated from post-fumigation samples. Pre- and post-fumigation populations are given in propagules per gram (ppg) of air-dried soil in the following table:

Plot	Fusarium		Trichoderma		Penicillium		Other	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
Telone C-17 with tarp	160	80	3360	15560	32640	4312	0	0
Telone C-17, no tarp	600	0	2440	11560	5280	2560	40	160
Adjacent MC-33 area	120	0	1920	8880	18400	3000	0	0
Remaining MC-33 area	120	0	1800	9960	21900	0	20	0

In general, populations of Fusarium spp. and Penicillium spp. were reduced and Trichoderma spp. increased following fumigation in all three treatment areas. Fusarium spp. were not isolated from post-fumigation samples from either the Telone C-17--no tarp or MC-33 treatment areas. Although low levels (80 ppg) of Fusarium spp. were isolated from the Telone C-17--with tarp treatment area, all treatments appreciably reduced the plant pathogen population levels.

The post-fumigation level of Fusarium spp. in the Telone C-17--with tarp treatment area could be a result of field reinvasion by the fungus, improper fumigant application at the sample points, fungal tolerance to the fumigant, or chance retrieval through the stated field or laboratory methodology. Regardless, none of the explanations can be proven.

The increased post-fumigation population levels of Trichoderma spp. are consistent with my earlier assays at the nursery (Marshall 1983) and with other assays elsewhere (Williams 1976). The post-fumigation increase may be a function of fumigant resistance, as noted by others (Baker and Cook 1974), allowing Trichoderma spp. to flourish in the absence or reduction of competing soil-borne fungi. Whatever the reason, the reduction of Fusarium spp. coupled with the rapid increase in competitive saprophytes such as Trichoderma spp. indicates the nursery is using a proper fumigant dosage in managing soil-borne plant pathogens.

The increase in Trichoderma may also be considered beneficial, as Trichoderma spp. are considered antagonistic toward plant pathogenic fungi (Baker and Cook 1974; Henis et al. 1983; Papavizas and Lewis 1983).

RECOMMENDATIONS

Although the Telone C-17 treatment reduced soil-borne plant pathogen populations to sufficiently low levels, I would not recommend the nursery abandon the use of MC-33 in favor of either Telone C-17 treatment based solely on these soil assays. Granted, fumigation costs per acre were significantly lower than for the MC-33 treatment (Telone C-17 with tarp = $830, no tarp = $525, MC-33 = $1085), but Telone C-17 treatment areas were small and may not have been expansive enough to determine effectiveness on all soil types throughout the nursery (14 fields).

Should nursery personnel find that weeds and insects have also been reduced to manageable levels in the Telone C-17 treatment areas, they may wish to conduct further broad-scale trials with Telone C-17. To further test Telone C-17's fungicidal capabilities, I recommend any further trials be conducted in a field with a recent rotation of mixed conifer genera or chronic history of soil-borne plant pathogen-related seedling mortality, such as the Fusarium-associated mortality in Field 12.

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